PATENT SPECIFICATION (11) 1 373 633

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(54) METHOD OF APPLYING CLINCH NUTS TO A PANEL

(71) We, MACLEAN-FOGG LOCK NUT Co., a Corporation organized and existing under the laws of the State of Delaware, United States of America, of 1000 Allanson Road, Mundelein, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of attaching clinch nuts to a panel, for example a sheet metal panel, and involves the use of clinch nuts in strip form. The present application is divided from Application No. 47877/71 (Serial No. 1,373,631) which describes and claims an apparatus for feeding clinch nuts to a workpiece.

It has been known for many years to secure a nut to a sheet over a hole therein so that the sheet could be secured to a frame or another sheet by a screw without requiring an assembler to hold the screw over the opening on one side of the sheet while a screw fastener was inserted from the other side. It has also been known to use a nut as a punch to pierce an opening in a sheet, and to deform either the sheet, or the nut, or both to clinch the nut in place on the sheet in the opening, thus at once forming the opening, locating the nut properly over the opening and securing the nut non-rotatively to the sheet. Such nuts are known as pierce or clinch nuts.

It may be appreciated that the use of clinch nuts is limited to extremely high volume applications since a considerable amount of tooling and set-up is required in the handling, selecting and feeding of individual nuts. Once designed, the tooling can be used only for the specific application for which it was designed, i.e., each design is good only for one application, and if any changes are made in the sheet or location and number of nuts, completely new tooling is required.

The most difficult area in the use of clinch nuts has been in the handling of the individual nuts. These must be selected from a hopper, oriented and fed individually to the proper location on the sheet to which they are to be applied. Present selecting and feeding mechanisms are limited as to the rate at which the clinch nuts can be handled.

According to the present invention there is provided a method of effecting the attachment to a panel of a clinch nut having a shank portion, with the aid of a die having an upper panel-supporting rim encompassing a recessed die area in which inner side surfaces slope downwardly and inwardly from the rim to a continuous co-planar cutting edge formed at the margin of a die cavity and related in size and contour to the shank portion of the nut, which method comprises the steps of locating the nut with its shank portion in axial alignment with the die cavity, said panel being disposed between the nut and die and resting against said upper panel-supporting rim of the die, applying force to the nut to move the nut linearly toward said die cavity, thereby to effect downward flexure of that portion of the panel extending between said upper panel-supporting rim and said cutting edge, the punching of a peripherally cut slug from the panel into the die cavity to pierce an aperture in the panel which conforms to the shape of said cutting edge but differs from the shape of the nut shank portion, forcing the nut shank portion into that aperture in the panel to mount the nut on the panel, and effecting securement of the nut in its mounted position on the panel on further movement of the nut through the panel.

The invention will become more apparent from the following detailed description of a preferred embodiment of the invention when taken together with the accompanying drawings in which:

Figure 1 is a section through a pierce nut, workpiece and clinching die of the type to which this invention may be applied;

Figure 2 is a plan view of the bottom die of Figure 1;

Figure 3 is an elevation in section of the bottom die of Figure 2 taken along line 3—3 thereof;

Figure 4 is a side elevational view of a known punch press in which this invention is installed;

Figure 5 is an enlarged longitudinal section through a strip of nuts of the kind used with this invention;

Figures 6 and 7 are plan and side views, respectively, on a reduced scale of the strip of Figure 5;

Figures 8 and 9 are sections through the strip of Figure 5 taken along lines 8—8 and 9—9, respectively, of Figure 7;

Figures 10 and 11 are, respectively, front and side elevations of the device of this invention, Figure 10 being a section taken along line 10—10 of Figure 11;

Figure 12 is a bottom view of the device of this invention taken along line 12—12 of Figure 10;

Figure 13 is a plan view in section through the device of Figure 10 taken along line 13—13 thereof;

Figure 14 is a side elevational view in section of the device of Figure 10 taken along line 14—14 of Figure 10;

Figure 15 is a front elevational view in section of the device similar to Figure 10, but showing the device in another stage of operation; and

Figure 16 is an enlarged vertical section through the shear insert of the tool.

The present embodiment of invention is based upon the use of pierce nuts in strip form in the manner described and claimed in our co-pending Application Serial No. 1,306,882. As there described, the nuts are formed in a strip of metal having rolled therein the requisite laterally extending flanges for pierce nuts, complete with properly threaded holes and with perforated connectors joining adjacent nuts together to preserve the original orientation and planar relation of the nuts to one another. The use of these "strip nuts", as they shall be referred to hereinafter, eliminates at once the vibration feed hoppers and their chutes or other devices normally used to select, orient and conduct the nuts to the point of application on the workpiece. It also eliminates dependence upon the limitations in the rate of selection and feed of the nuts imposed by such hoppers and chutes, as well as the time lost in correcting malfunctions thereof.

The strip nuts are inserted into a unit which has been affixed to the punch press in which the fastening of the nut to the workpiece is to be effected. Said unit is provided with means for converting the vertical reciprocating motion of the ram of the press into horizontal reciprocatory motion utilized to advance the strip, one nut at a time, to the punch which then severs the nut from the strip, pierces the workpiece with the severed nut and clinches the nut to the workpiece. Thus the feeding, severing, piercing and clinching operations are all performed by the said unit, utilizing the vertical motion and energy of the punch to power all of such operations. Several such units may be affixed to the same punch press to attach simultaneously a plurality of clinch nuts to a workpiece.

Referring now to the drawings, attention is first directed to Figures 1—3 which illustrate the preferred form of nut and clinching method according to the invention, although it is understood that other forms of nuts and clinching methods can also be used. In Figure 1, the nut is shown at 20 in the position it assumes with respect to a panel workpiece 21 which is shown in the form of a sheet metal panel, the nut having pierced an opening 22 in the workpiece and left a slug 23 which is to be ejected by succeeding slugs through a die cavity 24 in the bottom die 25. The piercing operation is effected by a punch 31 reciprocating in an opening 30 in a pad 26. In a preferred form, said bottom die 25, in co-operation with pad 26, also forms a boss 27 in workpiece 21 so that the surface 28 of nut 20 will be co-planar, or flush, with surface 29 of workpiece 21 to make it possible for the workpiece to be secured to another surface of the structure of which workpiece 21 is a part.

Figure 2 shows the bottom die 25 in plan view and also shows, for clarification, the inwardly projecting means at the corners 32 for deforming the corners of the nut 20 to effect the desired interlock with workpiece 21. Figure 3 shows a section through the corners 32 of bottom die 25 and the location, in dotted outline, of the workpiece 21 and flanged nut 20 at the beginning of the piercing operation. The work piece 21 is supported by the rim 19 at the edge of the land 18 formed on the die 25. The die has inner side surfaces 17 which slope downwardly and inwardly from the rim 19 to a cutting edge 16 formed at the margin of the die cavity 24. The die also has outer side surfaces 15 which slope downwardly and outwardly of the land 18.

During the operation of the method, the panel 21 is flexed downwardly from the rim 19 to the cutting edge 16 by the shank portion 14 of the nut 20 as it is driven by the punch 31, and is subsequently pierced by the co-operation of the nut 20 with the cutting edge 16. The panel is also embossed by the co-operation of pad 26 and the outer side surfaces 15.

The nuts as supplied to die 25 are shown in Figures 5—9. The individual nuts (Figures 8 and 9) are substantially square in cross-section and are formed with laterally and

oppositely extending flanges 33, 34 which serve as abutments to limit the movement of a nut into a workpiece it has pierced. The nuts are supplied in strip form, each nut being connected to its adjacent nut by portions 35, 36 of the flanges 33, 34 which remain when openings 37 are punched in the flanged strip of stock to form the individual nuts. The details of the particular strip form of nut and the method of making and applying it to a workpiece are described and claimed in our aforesaid co-pending Application Serial No. 1,306,882.

The nuts in the strip form of Figures 6 and 7 are furnished in coils 38, as shown in Figure 4, to a punch press 39 in which a nut application tool 40 is installed. The strip is fed to the tool 40 with the flanges 33, 34 uppermost as shown in Figure 5. If more than one nut is to be applied to a workpiece at a time, then as many application tools 40 and coils 38 are provided in punch press 39 as there are nuts to be simultaneously applied. Appropriate fixtures (not shown) will be provided to locate the workpiece in press 39 relative to the tools 40.

It has been found that although, ideally, the connecting portions 35, 36 should be punched out in the tool 40 to leave a neat and symmetrical nut 20, in practice these connecting portions are not generally visible to the exterior of the panel so that appearance is a minor factor. In addition, the slugs formed by the punched out connecting portions 35, 36 create a disposal problem which, if not properly solved, might result in having the slugs fall upon and get pressed into the workpiece to mar its appearance. In the form illustrated, therefore, the connecting portions are sheared in half so that each nut has one-half of a connecting portions 35, 36 extending from opposite sides thereof.

Tool 40 is shown in Figures 10—15. It is comprised of a vertically reciprocable plunger 41 and an assembly carried by said plunger and adapted to be suspended over bottom die 25 in a die block 42 secured to the bed (not shown) of punch press 39. The workpiece 21 is shown disposed between die 25 and the bottom of the tool assembly, and the nuts in strip form from coil 38 are shown at 43.

Referring to the cross sectional view of the tool shown in Figure 15, the punch 31 is secured to a mounting plate 44 which, in turn, is adapted to be secured to the reciprocating ram (not shown) of punch press 39. Plunger 41 is comprised of a punch retainer 45 which is centered in mounting plate 44 and which, in turn, centers the upper portion 46 of punch 31. A fastener 47 secures plate 44, punch 31 and retainer 45 together to function as a unit.

The bottom end of retainer 45 has a radially outwardly extending flange 48 and reciprocates in a recess 49 in a housing 50 which is split vertically in the plane of Figure 15 into two substantialy symmetrical parts 51 and 52 (Figure 11). The parts 51 and 52 are secured together by appropriate screws 53 (Figure 13). A compression spring 54 bears against the bottom of recess 49 and urges retainer 45 upward. A stop is provided for retainer 45 by a washer 55 on housing 50 extending over recess 49 and adapted to be engaged by flange 48.

Across the bottom of housing 50 is secured a feed block 56 which is formed with a T-shaped groove 57 in the upper part thereof and to the right of punch 31 as viewed in Figure 15 along whch the strip of nuts 43 is fed to the punch. The strip of nuts is retained in the groove by the bottom 58 of the housing 50. A finger spring 59 is secured to the sloping bottom of a centrally disposed groove 60 in feed block 56, said spring extending into groove 57 and into the space between adjacent nuts 20 in the strip of nuts 43. Spring 59 allows the strip of nuts to be fed toward punch 31, but prevents movement of the nuts in the opposite direction.

Adjacent punch 31, feed block 56 is provided with a shear insert 61 (Figure 16) which extends under the connecting flange parts 35 and 36 between adjacent nuts 20 and co-operates with punch 31 to shear said parts 35 and 36 in half. This leaves one-half of each connecting part with the nut 20 so that each nut has portions of the connecting parts extending from opposite sides thereof to present a symmetrical appearance. Next to shear insert 61 in feed block 56 is an opening 62 through which the severed nut is pushed to the workpiece by punch 31 for the piercing, embossing and clinching operations. Slots 63 are formed in feed block 56 adjacent opening 62 in which the connecting parts 35, 36 extending from the severed nut 20 are received and slide vertically. An embossing plate 64 is secured to the bottom of feed block 56 to co-operate with bottom die 25 during the embossing operation.

The strip of nuts 43 is advanced intermittently toward punch 31 by a pawl 65 which is bifurcated at its right hand end as viewed in Figures 10 and 15 to receive pivotally one end of a rocker arm 66, the other end of which is pivoted at 67 to a pivot block 68 horizontally adjustable in a recess 69 in housing 50. The nose 70 of pawl 65 is adapted to enter the opening 37 between adjacent nuts and is urged to enter said openings by a tension spring 71 connecting a tail portion 72 on pawl 65 and an elevated point on housing 50.

Referring now to Figure 10, horizontal reciprocating movement is imparted to pawl 65 by a drive link 73 connected at one end

to a pivot pin 74 passing through rocker arm 66 and movable therewith, and connected at its other end to a pin 75 which is also the shaft about which a roller 76 rotates. Said other end reciprocates in a recess 77 in housing 50, and the reciprocating movement is transmitted to rocker arm 66 and then through said rocker arm 66, at an amplified rate, to pawl 65 through a pin 78 connecting the arm to the pawl. Drive link 73 receives its reciprocating movement from a cam surface 79 (Figure 15) in a slot on one side of punch 31 on which roller 76 rolls. The return reciprocating movement is derived from a cam surface 80 in a slot on the other side of punch 31 in which a pin 81 rides, said pin having one end 82 connected to drive link 73.

It may be apparent from the foregoing description of drive link 73, roller 76 and pin 81 that as punch 31 moves downward, it first causes roller 76 and drive link 73 to move to the left as viewed in Figures 10 and 15, which then causes pawl 65, then received in an opening between adjacent nuts in the strip of nuts 43, to push said strip of nuts to the left as viewed in Figures 10 and 15 until the end nut of the strip is directly over opening 62. At the time the end nut is so located, roller 76 is out of contact with cam surface 79 and thereafter rides on the vertical surface 83 on the side of punch 31 which acts as a dwell surface while the punch continues its downward stroke. On the return or upward stroke, pin 81 engages cam surface 80 and causes a reverse movement of drive link 73. On such reverse movement pawl 65 will be moved out of the opening in the strip of nuts it then occupied and will slide over one nut and drop into the next opening in readiness to advance the end nut again under punch 31. Spring finger 59 holds the strip of nuts against backward movement with pawl 65.

The point at which the pawl 65 ceases to drive the strip of nuts 43 toward punch 31 is not critical, so long as it is within about $^1/_{32}$nd. of an inch of its designed position. A reasonably correct location of the end nut is assured in the present tool by causing the side of the nut to abut upon the side 84 of opening 62 at the end of the left-hand movement (Figure 15) of pawl 65. The exact location of the nut is achieved when the severed nut passes downward over a guide surface 88 (Figure 16) which shifts the nut into a precisely located portion 89 of opening 62. Excessive movement of pawl 65 beyond this point is avoided by adjusting the position of pivot block 68 in recess 69. The adjustment is accomplished by appropriately turning a screw 85 connected to block 68 and held against axial movement in housing 50.

A recess 86 is formed in housing 50 of a size and shape to accommodate the mechanisms used to effect the reciprocating movement of pawl 65, as well as to accommodate pawl 65 itself.

In the operation of the device of this invention, it is assumed that mounting plate 44 is secured to the ram of punch press 39 to be movable therewith and that housing 50 is secured to the bed or frame of press 39, or to an appropriate fixture which is secured to such bed or frame. Where more than one application tool 40 is used in one press, a fixture (not shown) will be prepared to locate the workpiece relative to the application tools so that the nuts 20 are secured at the proper places on the workpiece.

At the beginning of a cycle, when the ram of the press is raised, the parts of the application tool will appear as in Figure 10. It may be noted that the bottom portion of drive link 73 has a forwardly extending leg 73*a* the front vertical surface 87 of which is intended to serve as a stop to limit the initial insertion of the strip of nuts 43 into the tool. The leg 73*a* is relatively narrow and, as seen in Figure 14, operates in a slot in the side of opening 62 under punch 31 so that it is withdrawn as the workpiece is advanced over the opening 62. Without leg 73*a*, it would be possible to insert the strip of nuts into the tool to the extent that the end nut would be under punch 31 with the punch raised, and the subsequent downward movement of the punch and the resulting movement of pawl 65 to the left to advance a nut over opening 62 would cause the tool to jam, since the pawl could not move the strip of nuts beyond the opening 62 over which the end nut is already located. Leg 73*a* holds the strip of nuts back until drive link 73 and pawl 65 move forward, so that the end nut moves forward with the link and pawl.

Thus, with tool 40 in the stage shown in Figure 10, the strip of nuts 43 is advanced into contact with surface 87 by the operator of the press from a coil 38 located near the press, the workpiece is located under tool 40 by an appropriate fixture (not shown) to receive a nut 20 at a desired location thereon, and the punch press is then activated by the operator to commence an application cycle. With the operation of the press, punch 31 is lowered by the ram of the press against the resistance of spring 54. The lowering of punch 31 causes roller 76 to ride along cam surface 79 and thus move to the left as viewed in Figures 10 and 15. Drive link 73 is caused to move to the left by roller 76 and, through rocker arm 66, imparts this movement, at an amplified rate to pawl 65. The pawl 65 drops into an opening 37 between adjacent nuts in the inserted strip of nuts 43 and advances the strip of nuts into the tool. Pawl 65 is so located

relative to surface 87 on leg 73*a* that it will be in an opening 37 at the beginning of the movement of drive link 73. The position of pivot block 68 is adjusted in a manner to ensure such location of pawl 65.

As roller 76 leaves cam surface 79 and thereafter rides on the vertical surface 83 of punch 31, forward movement of the strip of nuts ceases, and continued downward movement of punch 31 lowers punch 31 upon the end nut 20 over opening 62, shears the said end nut from the strip of nuts 43 at the mid-point of the connecting flange parts 35, 36 and pushes the severed nut against, and then through, workpiece 21, punching out a rectangular slug from the workpiece in the process. The nut and workpiece are then clinched together in the die 25 and the punch is withdrawn by the upward movement of the ram of the press.

As punch 31 moves upward, pin 81 encounters cam surface 80 on the punch to cause the pin 81 to move to the right as viewed in Figure 15. Roller 76 is free at this point to be moved in the same direction by cam surface 79. Drive link 73 therefore moves to the right as viewed in Figure 15, taking pawl 65 with it through the operation of rocker arm 66. This strip of nuts 43, however, is held against backward movement with pawl 65 by finger spring 59 which has entered the space between adjacent nuts 20 and blocks such outward movement. At the end of the upward movement of punch 31 the cycle is complete.

It may be observed that the detail form of the nut and the corresponding form of clinching die are not material *per se* and that the invention herein described and claimed may be used with equal effectiveness with other detail forms of clinch nuts. The tool is a unit which may be designed for a given size nut in strip form and treated for design purposes as a part of a standard system for applying clinch nuts to a workpiece. The nuts are supplied in the form of a coiled strip, along with the application tool 40 and bottom die, and the tool designer then adapts the system to a particular fixture for handling the specific workpiece to which the nuts are to be fastened. No apparatus for singularizing, orienting, transporting to a die and successively applying loose nuts to a workpiece is required. Gang operation in a single punch press of two or more application tools is entirely possible, thereby vastly simplifying, speeding up and cheapening the application of clinch nuts to a workpiece.

It will also be appreciated that the apparatus described herein can be adapted for automatic feeding, locating, punching through and clinching to a sheet a pierce nut, which apparatus is a completely self-contained unit and is actuated by its own punch, such that the user of the apparatus need only mount the unit in his punch press along with guides or locaters for his particular workpiece and commence operation by merely inserting one end of a roll containing the pierce nuts in spaced and oriented condition into the unit.

A further advantage of the apparatus described herein is that it can be arranged to operate at a rate determined by the capabilities of the punch press to which it is applied, or by the rate at which workpieces can be fed to and removed from the punch press, rather than by the feed rate of the nuts or rate of selection of the nuts.

Our co-pending British Patent Application No. 4732/74 (Serial No. 1,373,632) discloses apparatus and methods similar to those described herein, and claims different aspects of them.

WHAT WE CLAIM IS:—

1. A method of effecting the attachment to a panel of a clinch nut having a shank portion, with the aid of a die having an upper panel-supporting rim encompassing a recessed die area in which inner side surfaces slope downwardly and inwardly from the rim to a continuous co-planar cutting edge formed at the margin of a die cavity and related in size and contour to the shank portion of the nut, which method comprises the steps of locating the nut with its shank portion in axial alignment with the die cavity, said panel being disposed between the nut and die and resting against said upper panel-supporting rim of the die, applying force to the nut to move the nut linearly toward said die cavity, thereby to effect downward flexure of that portion of the panel extending between said upper panel-supporting rim and said cutting edge, the punching of a peripherally cut slug from the panel into the die cavity to pierce an aperture in the panel which conforms to the shape of said cutting edge but differs from the shape of the nut shank portion, forcing the nut shank portion into that aperture in the panel to mount the nut on the panel, and effecting securement of the nut in its mounted position on the panel on further movement of the nut through the panel.

2. A method according to claim 1, wherein the securement of the nut in its mounted positon is effected by metal shaved from the nut shank portion during movement of the nut shank portion into the die cavity and the compression of said shaved metal in a dimple recess in the die.

3. A method according to claim 1 or 2, wherein said die is formed with outer side surfaces sloping downwardly and outwardly of said rim to a panel supporting surface disposed below the rim, and the means used to apply said force to the nut is arranged to

effect downward flexure of the portion of the panel surrounding said rim so that the body of the panel lies on said panel supporting surface, thus to form a boss in the panel around the nut so attached.

4. A method according to claims 1, 2 and 3, wherein said rim forms the edge of a land surrounding said inner surface.

5. A method of effecting the attachment to a panel of a clinch nut according to claim 1 substantially as herein described with reference to the accompanying drawings.

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1373633 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1.

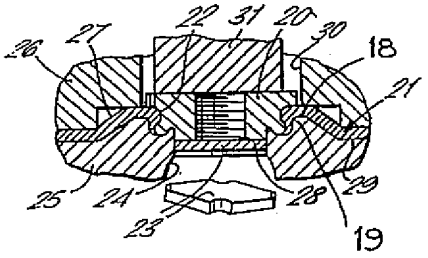


FIG. 2.

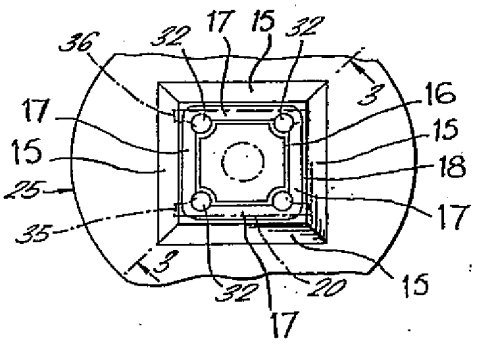


FIG. 3.

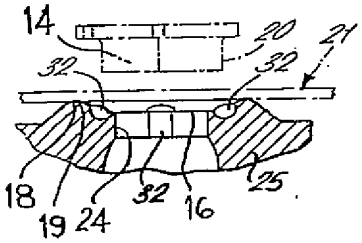


FIG. 4.

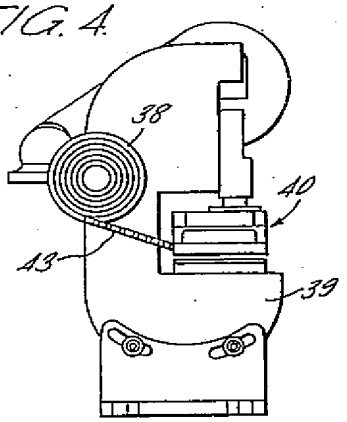


FIG. 5.

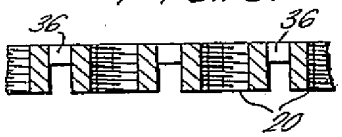


FIG. 6.

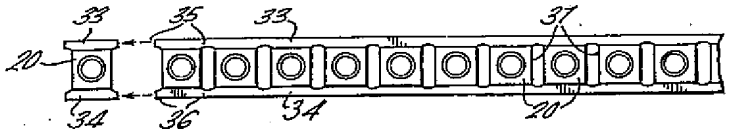


FIG. 7.

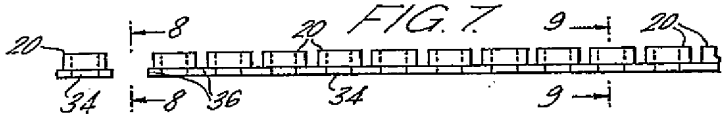


FIG. 8.

FIG. 9.

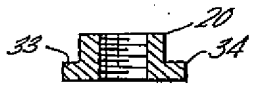


FIG. 10.

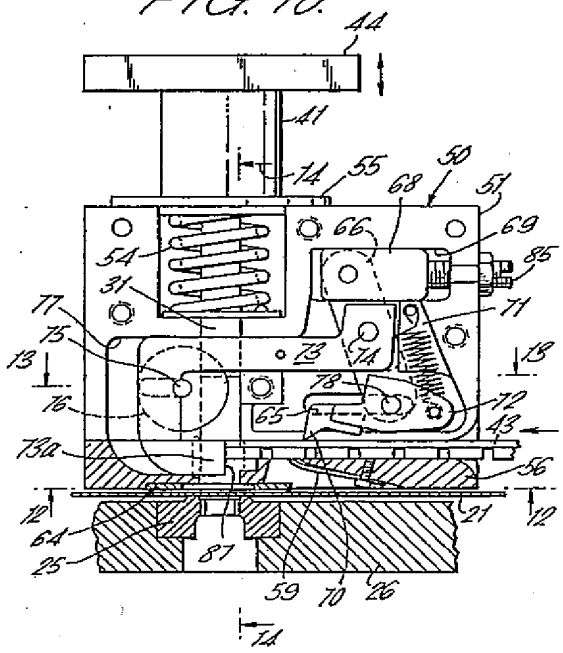
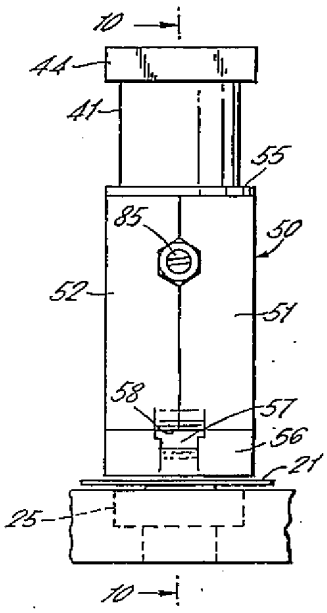


FIG. 11.



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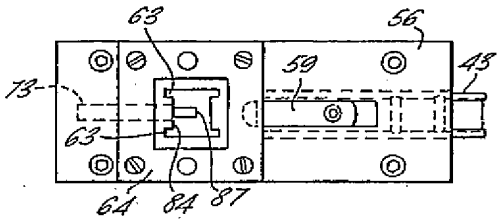

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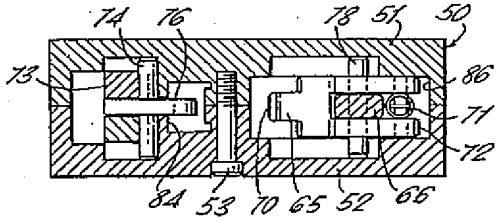

FIG. 14.

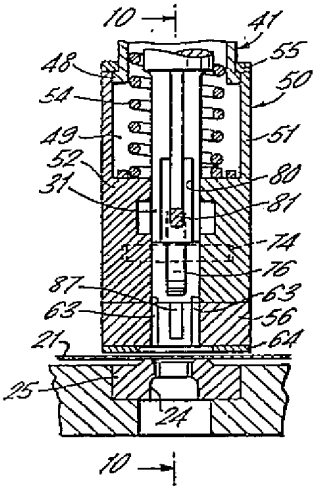

FIG. 15.

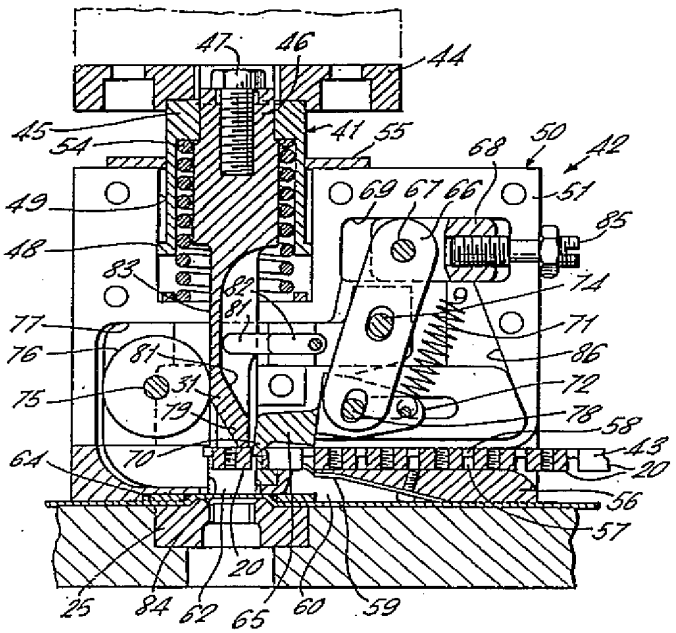
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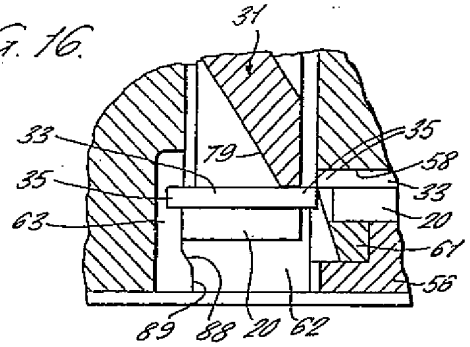
FIG. 16.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